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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF CHEMISTRY—BULLETIN No. 154.

H. W. WILEY, CHIEF OF BUREAU.

CHEMICAL ANALYSIS AND COMPOSITION OF IMPORTED HONEY FROM CUBA, MEXICO, AND HAITI.

BY

A. HUGH BRYAN,
Chief Sugar Laboratory,

WITH THE COOPERATION OF

ARTHUR GIVEN AND SIDNEY SHERWOOD,
Assistant Chemists.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

Monograph

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LETTER OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., February 13, 1912.

SIR: I have the honor to transmit for your approval a report on the "Chemical Analysis and Composition of Imported Honey from Cuba, Mexico, and Haiti."

During the year ending June 30, 1911, statistics show that 1,350,636 pounds of honey were imported into the United States, of which 601,572 pounds came from Cuba, 578,052 pounds came from Mexico, and 129,744 pounds came from Haiti, while 41,268 pounds came from all other countries. These figures show the necessity for knowing something of the composition of honeys from the sources named. The greater part of the analytical work was performed by A. Given and S. F. Sherwood, of the Sugar Laboratory.

I recommend that this report be published as Bulletin 154 of the Bureau of Chemistry.

Respectfully,

H. W. WILEY,
Chief.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
Methods of analysis	7
Polarizations	7
Reducing sugars and sucrose	8
Water	8
Ash	8
Dextrin	8
Undetermined matter	9
Free acid	9
Tabulation of analytical results	9
Discussion of results	13
Physical characteristics	13
Polarizations	13
Analytical data	14
Tests for adulteration	15
Commercial invert sugar	15
Commercial glucose	16
Summary	16
Chemical literature on honey from 1907 to 1911	17

CHEMICAL ANALYSIS AND COMPOSITION OF IMPORTED HONEY FROM CUBA, MEXICO, AND HAITI.

INTRODUCTION.

During the year 1906 the Sugar Laboratory of the Bureau of Chemistry, under the direction of C. A. Browne, made a chemical examination of 100 American honeys of known purity, the results being published in Bulletin 110 of the Bureau of Chemistry. In further elaboration of this study the same laboratory has examined 72 imported honeys, and the chemical results obtained on these samples appear to coincide closely with those for American honeys. No attempt has been made to determine whether the source of these samples would cause them to be classed as adulterated, but they do not respond to the usual tests for adulteration, and the figures obtained on their complete analysis compare favorably with those for pure honeys. The samples when received, however, were extremely dirty in all but two cases, being poorly extracted. Small particles of the comb and wax were present as well as pieces of sticks and dirt, and in many cases dead bees and other insects were found. To remove these and clean the samples the bottles were immersed in water and heated to from 45° to 50° C., until a complete solution of the crystallized dextrose was effected, at the same time rendering the sample decidedly liquid. While hot it was strained through a fine linen cloth and the refuse thus removed. The samples were then set away for analysis. The methods employed were practically the same as used by Browne on the American honeys and are as follows:

METHODS OF ANALYSIS.

POLARIZATIONS.

Transfer 26 grams of honey to a 100 cc (true cc) flask with water, and add 5 cc of alumina cream; make up the solution to volume at 20° C., filter and polarize the liquid at once for the "Immediate polarization." Transfer 50 cc of this filtrate to a 50 to 55 cc flask; add 5 cc of concentrated hydrochloric acid, and allow the whole to stand over night for inversion. Place the remainder of the filtrate in a flask, after removing the quantity necessary for the reducing-sugar determination, and allow to stand over night. On the following

day again polarize the solutions at 20° and also at 87° C., making a total of five different polarizations on each sample.

REDUCING SUGARS AND SUCROSE.

Make up 10 cc of the solution used for immediate polarization before inversion to 250 cc with water and use 25 cc for reduction according to Allihn's method. Calculate the results expressed as dextrose to invert sugar by the factor 1.044. For the determination of total sugars after inversion transfer 10 cc of the 55 cc solution to a 250 cc flask, neutralize with sodium carbonate, made up to the mark with water, and employ 25 cc as before for reduction. Calculate the results to invert sugar and then to percentage. Subtract the per cent of invert sugar before inversion from this figure and multiply the difference by the factor 0.95 to obtain the per cent of sucrose.

WATER.

Weigh 2 grams of the sample in a flat-bottom aluminum dish 2.5 inches in diameter, containing from 10 to 15 grams of thoroughly washed, dried, and ignited quartz sand. Weigh a small glass stirring rod with the dish and sand, and after the addition of the honey dissolve the latter in 5 to 10 cc of distilled water and thoroughly incorporate with the sand by stirring with the rod. Then place the dish in a vacuum oven and dry to constant weight at from 68° to 72° C., under a 20 to 24 inch vacuum.

ASH.

Carefully weigh 5 grams of the honey in a tared platinum dish, add a few drops of olive oil, and heat the whole over a flame, using care not to lose by spattering. Ignite at a low red heat without fusing the ash.

DEXTRIN.

Transfer 8 grams of the honey to a 100 cc flask with 4 cc of water and add sufficient absolute alcohol to bring up to the mark. (The transfer is best made by decanting as much as possible of the liquified honey into the flask, then adding 2 cc of water to the dish to take up adhering honey and again decanting. By using 1 cc more of the water in two successive washings and adding a few cubic centimeters of the absolute alcohol each time before decanting, the honey can be completely transferred without the necessity of using more than 4 cc of water.) Finally rinse out the dish with absolute alcohol and then add it to the flask with continual agitation until the volume has reached 100 cc. Allow this to stand until the dextrin has settled out on the sides of the flask and the supernatant liquid is perfectly clear.

Then decant the clear solution through a filter and wash the precipitated residue with 10 cc of cold 95 per cent alcohol to remove the adhering liquid, pouring the washings also through the filter. Dissolve the residue adhering to the flask and the particles which may have been caught upon the filter in a little boiling water and wash into a tared platinum dish. Evaporate the contents of the latter and dry in a vacuum oven to constant weight as for the moisture determination.

After determining the weight of the dried alcohol precipitate, redissolve the latter in water and make up to a definite volume. If the alcohol precipitate weighs as much as 0.5 gram, the volume should be 50 cc; from 0.5 to 1 gram, it should be 100 cc; from 1 to 1.5 grams, 150 cc, and so on. Determine the sugars in aliquots from the filtered solution of the alcohol precipitate both before and after inversion. The total precipitate less invert sugar and sucrose gives the weight of dextrin, from which the per cent can be obtained.

UNDETERMINED MATTER.

The figure for the undetermined matter is obtained by subtracting from 100 the sum of the percentages of moisture, invert sugar, sucrose, dextrin, and ash.

FREE ACID.

Dissolve 10 grams of honey in water and titrate with tenth-normal sodium hydroxid, using phenolphthalein as indicator. Express the acidity as formic acid. (It is a question, however, whether that acid predominates in the honey.)

TABULATION OF ANALYTICAL RESULTS.

The analytical results are tabulated and classified according to the geographical source of the honey, whether from Cuba, Mexico, or Haiti. Following the analyses of samples from the individual countries an average is given for each of the three, together with the maximum and minimum results of each determination. An average of the total number is also given, and the maximum and minimum results of each determination without regard to source. Following these results are given the figures for the maximum, minimum, and average results obtained by C. A. Browne on American honeys. (See Bulletin 110, Bureau of Chemistry, p. 38.)

Results of the examination of 72 samples of imported honeys and comparison with American honeys.

CUBAN HONEYS.

Serial number.	Physical characteristics.			Polarizations (°V).							Complete analysis.							Serial number.
				Direct.				Invert.										
	Color.	Granulation.	Odor and flavor.	Immediate.	Constant.	Birotation.	At 87°.	At 20°.	At 87°.	Difference.	Water.	Invert sugar.	Sucrose.	Ash.	Dextrin.	Undetermined.	Free acid as formic.	
											Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
5578	Dark amber	Semisolid	Strong aromatic	− 6.05	− 9.60	3.55	+15.50	−11.44	+12.87	24.31	19.27	70.64	0.30	0.20	2.96	6.63	0.19	5578
5591	Very light	Liquid	Mild	− 7.65	−10.70	3.05	+16.40	−12.10	+15.40	27.50	16.05	74.58	.18	.07	1.42	7.70	.08	5591
5594	Dark amber	do	Strong aromatic	−11.10	−12.15	1.05	+11.60	−13.20	+10.23	23.43	23.13	69.03	.02	.18	1.36	6.28	.12	5594
5595	Amber	do	Mild	−11.70	−12.60	.90	+13.15	−13.86	+12.10	25.96	19.84	68.91	.39	.18	2.61	8.07	.14	5595
5597	do	do	do	−18.25	−19.10	.85	+ 6.70	−20.79	+ 4.73	25.52	17.02	76.70	1.54	.17	.36	4.21	.07	5597
5599	Very light	do	do	−17.60	−18.75	1.15	+ 8.00	−20.57	+ 6.93	27.50	16.64	77.56	.76	.15	.61	4.28	.07	5599
5606	do	do	do	−20.00	−20.80	.80	+ 6.20	−22.00	+ 4.51	26.51	17.29	76.54	.65	.15	.29	5.08	.07	5606
5622	Dark amber	do	Strong	− 7.20	− 8.60	1.40	+17.00	− 8.86	+14.85	23.71	20.11	68.09	1.59	.30	3.96	5.95	.15	5622
5715	do	do	do	−12.35	−13.25	.90	+10.20	−15.07	+ 8.80	23.87	22.59	69.79	2.27	.29	1.99	3.07	.20	5715
5716	do	do	Rank	−14.00	−14.70	.70	+ 9.05	−16.28	+ 8.36	24.64	22.47	70.03	1.92	.26	1.66	3.66	.20	5716
5769	Amber	do	Strong	−12.80	−13.60	.80	+ 9.70	−14.85	+ 8.36	23.21	24.09	68.51	1.09	.28	1.68	4.35	.22	5769
5933	Dark amber	do	do	−10.30	−11.20	.90	+11.70	−13.09	+ 9.96	23.05	22.09	69.39	2.99	.23	1.47	3.83	.20	5933
5999	do	Semisolid	do	−13.55	−14.50	.95	+ 9.90	−16.06	+ 8.14	24.20	19.84	71.64	1.79	.21	1.05	5.47	.15	5999
6053	do	do	do	−13.80	−14.00	.20	+ 9.60	−16.01	+ 8.14	24.15	20.82	70.71	1.65	.28	1.43	5.11	.16	6053
6079	Amber	Liquid	do	−19.65	−21.10	1.45	+ 6.00	−23.43	+ 5.06	28.49	20.50	73.73	1.94	.24	1.39	2.20	.20	6079
6094	Brown	Slight crystal.	do	−11.45	−12.50	1.05	+10.80	−14.41	+10.45	24.86	25.37	68.69	.00	.28	1.18	4.48	.43	6094
6095	Amber	do	Rank	−15.20	−16.10	.90	+ 9.00	−18.37	+ 7.81	26.18	22.52	73.35	.91	.28	1.26	1.67	.32	6095
6101	Light	Solid	Mild	−16.50	−17.50	1.00	+ 8.60	−19.91	+ 7.15	27.06	21.20	71.85	1.13	.27	1.28	4.27	.27	6101
6102	do	do	do	−15.00	−16.00	1.00	+10.20	−18.81	+ 8.25	27.06	22.02	72.62	2.62	.28	1.23	1.23	.25	6102
6103	Amber	Liquid	do	−13.50	−14.85	1.35	+11.90	−17.49	+ 9.35	26.84	17.27	73.58	.81	.25	1.84	6.25	.09	6103
6143	do	do	do	−13.70	−15.40	1.70	+10.40	−17.49	+ 9.24	26.73	20.80	74.00	.14	.20	1.05	3.81	.25	6143
6144	do	do	do	−13.70	−14.95	1.25	+10.30	−17.49	+ 8.91	26.40	22.25	73.12	.30	.24	1.05	3.04	.23	6144
6224	Light	Slight crystal.	do	−12.10	−14.05	1.95	+11.80	−14.74	+11.22	25.96	20.25	74.00	.00	.14	.61	5.00	.03	6224
6226	Brown	Liquid	Rank	− 9.80	−11.30	1.50	+12.00	−12.98	+11.88	24.86	23.70	68.23	.00	.22	1.40	6.45	.....	6226
6227	Light	Slight crystal.	Mild	−15.20	−16.30	1.10	+10.15	−18.21	+ 9.35	27.56	19.95	75.81	.00	.16	.64	3.44	.17	6227
6234	Amber	Liquid	do	−13.45	−14 90	1.45	+10.40	−16.17	+ 9.46	25.63	22.75	72.65	.73	.14	.60	3.13	.06	6234
6445	Dark amber	do	Rank	−11.05	−12.25	1.20	+12.20	−13.37	.....	.....	22.15	69.88	.58	.39	2.19	4.81	.07	6445
6446	Amber	do	Mild	−14.00	−15.50	1.50	+10.40	−16.72	+ 8.80	25.52	20.50	72.88	1.00	.17	.80	4.65	.06	6446
6448	do	do	do	− 8.90	− 9.90	1.00	+13.70	−11.66	+12.21	23.87	23.10	69.58	1.38	.21	1.12	4.61	.07	6448
6481	do	do	do	−12.20	−13.35	1.15	+11.50	−15.02	+10.45	25.47	22.37	71.23	1.19	.17	.75	4.29	.04	6481
6559	Light	do	do	−13.50	−14 90	1.40	+ 8.00	−17.05	+ 6.16	23.21	27.00	69.23	.37	.12	.42	2.86	.10	6559

6666	Amber	do	do	− 9.80	−12.30	2.50	+13.00	−13.64	+12.10	25.74	20.00	70.69	.00	.36	3.28	5.67	.00	6666
6668	do	do	do	− 7.10	− 9.20	2.10	+15.80	−10.67	+14.63	25.30	20.15	71.08	.32	.24	2.10	5.11	.03	6668
Maximum				−20.00	−21.10	3.55	+17.00	−23.43	+15.40	28.49	27.00	77.56	2.99	.39	3.96	8.07	.43	
Minimum				− 6.05	− 8.60	.20	+ 6.00	− 8.86	+ 4.51	23.05	16.05	68.09	.00	.07	.29	1.23	.00	
Average for 33 Cuban samples				−12.79	−14.12	1.33	+10.94	−15.81	+ 9.56	25.37	21.07	71.77	.94	.22	1.43	4.57	.14	

MEXICAN HONEYS.

5592	Dark amber	Semisolid	Strong	−11.70	−12.80	1.10	+10.30	−15.51	+ 9.02	24.53	19.43	74.05	0.68	0.14	0.93	4.77	0.12	5592
5601	do	do	do	− 9.60	−10.50	.90	+13.00	−11.83	+12.10	23.93	20.47	71.20	.99	.20	1.63	5.51	.15	5601
5604	Amber	do	do	− 7.25	− 8.60	1.35	+13.35	− 9.90	+12.87	22.77	21.74	70.07	1.08	.20	1.34	5.57	.14	5604
5618	Dark amber	Liquid	do	− 8.00	− 8.50	.50	+15.70	− 9.35	+13.42	22.77	19.72	71.64	.82	.21	2.33	5.28	.15	5618
5619	do	Semisolid	do	− 8.00	− 8.60	.60	+15.50	− 9.35	+13.42	22.77	21.23	73.00	.00	.18	1.51	4.08	.16	5619
5621	do	Liquid	Aromatic	−12.85	−13.90	1.05	+11.30	−14.52	+ 9.90	24.42	19.50	73.52	.79	.13	1.05	5.01	.15	5621
5630	do	do	Strong	−10.00	−10.90	.90	+13.60	−12.32	+11.66	23.98	19.57	72.44	.42	.20	1.98	5.39	.15	5630
5644	do	do	Rank	− 9.75	−10.10	.35	+13.70	−11.44	+11.77	23.21	21.42	70.68	.03	.19	1.65	6.03	.16	5644
5647	Amber	do	Aromatic	−17.00	−17.00	.00	+ 7.00	−18.76	+ 6.38	25.14	22.09	72.56	.42	.18	.52	4.23	.14	5647
5662	Dark amber	do	Strong	−12.25	−12.40	.15	+12.50	−13.92	+11.00	24.92	19.56	72.44	.76	.18	1.34	5.72	.15	5662
5663	do	do	Aromatic	−11.20	−11.30	.10	+12.20	−12.43	+11.11	23.54	20.72	71.20	.76	.15	1.39	5.78	.16	5663
5723	Amber	do	Strong	−11.50	−11.75	.25	+12.50	−13.20	+10.89	24.09	20.87	71.55	.00	.15	1.13	6.30	.15	5723
6076	do	do	Aromatic	−13.30	−13.50	.20	+11.00	−14.91	+ 9.35	24.26	20.31	72.36	.00	.19	1.27	5.87	.13	6076
6080	do	Slight cryst	Mild	−14.80	−15.70	.90	+ 9.15	−17.71	+ 8.14	25.85	21.92	74.00	.25	.34	.95	2.54	.24	6080
6088	do	Liquid	do	−22.90	−24.15	1.25	+ 3.20	−26.07	+ 2.86	28.93	21.22	71.00	3.98	.34	2.08	1.35	.35	6088
6089	do	do	do	−15.20	−16.05	.85	+10.10	−18.04	+ 9.35	27.39	22.37	69.27	2.95	.58	3.48	1.35	.24	6089
6090	do	do	Strong	−14.15	−14.75	.60	+ 9.50	−17.27	+ 8.03	25.30	19.93	73.76	1.23	.19	1.27	3.62	.15	6090
6091	do	Semisolid	Mild	−14.60	−15.50	.90	+ 9.70	−17.82	+ 8.91	26.73	20.77	74.12	1.57	.34	1.02	2.18	.29	6091
6108	Dark amber	Liquid	do	−12.60	−13.90	1.30	+10.40	−15.68	+10.34	26.02	22.60	72.58	.00	.33	1.15	3.34	.23	6108
6109	do	Slight cryst	do	−13.20	−14.75	1.55	+10.30	−16.78	+10.12	26.90	21.25	73.88	.00	.35	1.80	2.62	.31	6109
6223	Very dark	Liquid	Strong	−11.50	−12.00	.50	+11.50	−13.86	+10.23	24.09	24.40	70.62	1.57	.28	.90	2.13	.07	6223
6225	Dark amber	do	do	−14.10	−15.45	1.35	+10.10	−17.49	+ 9.68	27.17	21.20	75.04	.00	.28	1.16	2.32	.31	6225
6520	do	do	do	−10.10	−11.70	1.60	+13.60	−13.09	+12.98	26.07	21.70	71.96	.18	.32	1.57	4.27	.....	6520
Maximum				−22.90	−24.15	1.60	+15.70	−26.07	+13.42	28.93	24.40	75.04	3.98	.58	3.48	6.30	.35	
Minimum				− 7.25	− 8.50	.00	+ 3.20	− 9.35	+ 2.86	22.77	19.43	69.27	.00	.13	.52	1.35	.07	
Average for 23 Mexican samples				−12.41	−13.21	.80	+11.27	−14.84	+10.15	24.99	21.04	72.30	.80	.25	1.45	4.15	.19	

HAITIAN HONEYS.

5584	Amber	Solid	Mild	−17.70	−19.50	1.80	+ 4.35	−22.44	+ 4.73	27.17	18.60	76.34	2.33	0.23	0.46	2.03	0.10	5584
5593	Light	do	do	−16.50	−19.10	2.60	+ 6.15	−21.40	+ 5.50	26.90	19.70	75.10	2.44	.17	.32	2.27	.09	5593
5607	Amber	do	do	−17.00	−17.90	.90	+ 7.40	−19.14	+ 6.60	25.74	19.01	73.32	1.48	.15	.58	5.46	.10	5607
5611	do	Semisolid	do	−14.85	−15.70	.85	+ 8.50	−16.89	+ 6.82	23.71	22.71	71.64	.01	.18	.61	4.85	.13	5611
6096	Dark amber	do	do	−19.60	−20.65	1.05	+ 4.50	−22.66	+ 3.52	26.18	24.17	73.08	.00	.12	.40	2.23	.26	6096
6127	Amber	Slight crystal	do	−17.30	−18.50	1.20	+ 5.90	−20.68	+ 5.50	26.18	23.10	75.19	.00	.28	.51	.92	.28	6127
6145	Very dark	do	Strong	−16.60	−18.00	1.40	+ 7.40	−19.58	+ 6.05	25.63	21.70	73.73	1.15	.18	.55	3.24	.02	6145
6146	Dark amber	do	do	−18.60	−19.90	1.30	+ 6.30	−22.11	+ 4.84	26.95	22.05	76.73	.00	.12	.44	.66	.21	6146

Results of the examination of 72 samples of imported honeys and comparison with American honeys—Continued.

HAITIAN HONEYS—Continued.

Serial number.	Physical characteristics.			Polarizations (°V).						Complete analysis.							Serial number.
				Direct.				Invert.									
	Color.	Granulation.	Odor and flavor.	Immediate.	Constant.	Birotation.	At 87°.	At 20°.	At 87°.	Difference.	Water.	Invert sugar.	Sucrose.	Ash.	Dextrin.	Undetermined.	Free acid as formic.	
											Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
6172	Light	Liquid	Mild	−14.70	−15.80	1.10	+ 8.80	−18.37	+ 7.70	26.07	23.85	74.12	.00	.06	.35	1.62	.22	6172
6447	Amber	Slight crystal	do	−14.60	−15.70	1.10	+ 8.50	−17.27	+ 6.93	24.20	23.70	72.08	.57	.08	.26	3.31	.07	6447
6449	Light	Liquid	Rank	−11.30	−12.50	.20	+10.70	−13.31	+10.12	23.43	25.05	69.15	.11	.45	1.65	3.59	.03	6449
6482	Amber	Slight crystal	Mild	−16.10	−18.05	1.95	+ 8.00	−19.69	+ 6.38	26.07	19.95	75.88	.63	.09	.27	3.18	.08	6482
6483	Light	do	do	−14.70	−16.75	2.05	+ 8.50	−18.48	+ 7.15	25.63	21.80	73.81	.10	.09	.47	3.73	.07	6483
6558	do	do	do	−13.25	−15.30	2.05	+10.10	−16.67	+ 9.02	25.69	21.70	73.35	.00	.17	.64	4.14	.03	6558
6561	Amber	do	do	−14.60	−16.20	1.60	+ 8.80	−17.77	+ 7.48	25.25	22.70	73.15	.00	.09	.49	3.67	.07	6561
6562	do		Rank	−14.80	−16.30	1.50	+ 8.60	−18.43	+ 6.93	25.36	22.50	73.12	.00	.11	.47	3.80	.08	6562
Maximum				−19.60	−20.65	2.60	+10.70	−22.66	+10.12	27.17	25.05	76.73	2.44	.45	1.65	5.46	.28	
Minimum				−11.30	−12.50	.85	+ 4.35	−13.31	+ 3.52	23.43	18.60	69.15	.00	.06	.26	.66	.03	
Average for 16 Haitian samples				−15.76	−17.22	1.46	+ 7.66	−19.05	+ 6.58	25.63	22.02	73.73	.55	.16	.53	3.01	.12	

TOTALS IMPORTED HONEYS.

Maximum	−22.90	−24.15	3.55	+17.00	−26.07	+15.40	28.93	27.00	77.56	3.98	0.58	3.96	8.07	0.43			
Minimum	− 6.05	− 8.50	.00	+ 3.20	− 8.86	+ 2.86	22.77	16.05	68.09	.00	.06	.26	.66	.00			
Average for 72 samples	−13.34	−14.52	1.18	+10.31	−16.22	+ 9.08	25.30	21.26	72.38	.80	.21	1.24	4.11	.15			

TOTALS UNITED STATES HONEYS LEVOROTATORY.

Maximum	−21.90	−24.80	11.60	+23.70	−29.26	+23.21	33.55	26.88	83.36	10.01	0.90	7.58	7.45	0.25			
Minimum	+ 3.70	− .30	1.40	+ .50	− 1.32	− .66	23.32	12.42	62.23	.00	.03	.04	.04	.04			
Average for 92 United States honeys	−11.24	−14.73	3.49	+10.15	−19.16	+ 7.91	27.07	17.70	74.98	1.90	.18	1.51	3.73	.08			

DISCUSSION OF RESULTS.

PHYSICAL CHARACTERISTICS.

With but two exceptions all of the samples received were extracted, Nos. 5591 and 5599 being in the broken comb. Of the total number 40 per cent were more or less crystallized, practically all those from Haiti showing crystallization, and the others were liquid. Of the American honeys 80 per cent showed granulation, this difference no doubt being due to the higher moisture content of the imported honeys. The color of the honeys was rather uniform, ranging from an amber to a dark amber, while only 13 out of the 72 were light in color. The aroma and flavor were far from pleasing, in most cases being very strong with a tendency to be aromatic. It can be truthfully said that in the condition in which they were received they were scarcely edible and certainly could not be considered as a table delicacy such as honey is expected to be.

There is no marked difference between the honeys of the three countries, though the Haitian products resemble the American products more than do those of Cuba or Mexico, and have a milder, pleasanter flavor, usually accompanied by a lighter color.

POLARIZATIONS.

Not one of the 72 samples was dextro-rotary, all turning the plane of polarized light to the left. The birotation was, on the average, less than in the American honeys. This may be accounted for in part by the fact that a longer time elapsed between making up the solution and taking the immediate reading in this case than with the United States honeys, due to trouble experienced in filtering. The greater water content of the imported honeys would also tend to diminish the birotation by lowering the supersaturation of the reducing sugars. The constant direct rotation at 20° C. agrees closely with that found for American honeys, namely, −14.52° and −14.73°. The direct polarization at 87° C. shows a like agreement, +10.31° and +10.15°. The invert reading at 20° C. did not show so close an agreement, being a little higher in American honeys than in the imported samples, namely, −19.16° and −16.22°, while the invert reading at 87° C. was closer and just the reverse; that is, for the imported +9.08° and American +7.91°. No calculations for sucrose were made by the Clerget formula, as it has been established that the results so obtained are of no value as a quantitative estimation.

C. A. Browne found a constant for pure honey which seems to have a value in analytical work. This is the algebraic difference between the reading of the invert solution at 20° and at 87° C. and is ex-

pressed in the table as "Difference." The average figure for American honeys was 27.07 (calculated to dry substance, about 33), while for the imported honeys at was 25.30, or, calculated to dry substance, a little over 32. Thus it is seen that when calculated to dry substance this number is practically the same for the imported and domestic honeys and would seem to indicate a chemical value for honeys.

ANALYTICAL DATA.

Moisture.—The imported honeys contain 3.56 per cent more water than the American honeys, 21.26 per cent as compared with 17.70 per cent. This average figure is a little higher than that given by König for German honeys, namely, 20.60 per cent. The increase in moisture over the American honeys is probably due to the climate, as the islands are naturally more humid, and therefore the bees can not bring their product down to the same consistency.

Invert sugar.—The American honeys contain 2.6 per cent more invert sugar than the imported. If, however, the data are calculated to the same water content or to dry substance very little difference is noted.

Sucrose.—Here again the imported honey is much lower than the American product, being less than one-half, namely, an average of 0.80 per cent, as compared with 1.90 per cent. The highest percentage found was only 3.98, which is far below the limits for sucrose generally recognized, i. e., from 8 to 10 per cent.

Ash.—The ash average in both cases is about the same, namely, 0.21 per cent and 0.18 per cent. The highest figure recorded was only 0.58 per cent.

Dextrin.—It is a noticeable fact that the dextrin figures for the individual samples of imported honeys vary within much narrower limits (3.96 to 0.26) than do those of the American honeys (7.45 to 0.04), but the averages for both classes are nearly the same, differing by less than 0.30 per cent, the imported honeys being 1.24 per cent and the American 1.51 per cent. Tropical honeys, as from the Hawaiian Islands, often contain a large amount of dextrin, owing to the presence of honeydew, which is gathered by bees from the exudation of various insects. The samples examined, however, contained no large amounts of honeydew.

Undetermined matter.—The average figure for undetermined matter is not much higher for the imported honeys than for the American honeys, although this might be expected, due to the fact that the imported honeys were dirtier than the others and poorly extracted.

Acidity.—The average acidity of imported honey is about twice that of American honey, although the extremes are about the same in both cases.

Tannin bodies.—The honeys were all tested with a solution of ferric chlorid. Only one, No. 6226, gave a decided reaction for tannin, and two others, Nos. 5594 and 6223, were doubtful.

TESTS FOR ADULTERATION.

All of the samples were tested for the usual forms of adulteration, namely, commercial invert sugar and commercial glucose.

COMMERCIAL INVERT SUGAR.

Browne's[1] test (anilin acetate) and Fiehe's[2] test (resorcin in hydrochloric acid) were used. The former was made by adding to 5 cc of a 50 per cent honey solution in a test tube, 1 cc of a solution of anilin acetate (5 cc of colorless C. P. anilin, 5 cc of water, and 2 cc of glacial acetic acid). The anilin acetate was carefully run down the side of the tube so as to form a layer on top and not mix with the honey solution. At the junction of the two liquids, after shaking slightly, a red ring or color is noted if commercial invert sugar is present. Only one of the samples, No. 6226, responded at all to this test, and the color developed in this case was so slight as not to be mistaken for the addition of commercial invert sugar.

Fiehe's test was conducted as follows, a slight variation of the original method being employed: Place 10 cc of a 50 per cent honey solution in a test tube and run in 5 cc of ether on top. Shake contents vigorously and allow to stand for some time until the ether layer is perfectly clear; transfer 2 cc of this clear ether solution to a small test tube and add a large-sized drop of the resorcin solution (1 gram in 100 cc hydrochloric acid). Shake and note the color immediately.

With as little as 1 per cent of Herzfeld's commercial invert sugar[3] present the drop of acid in the bottom assumed immediately an orange-red color, turning to a dark red. In only five cases (Cuba, Nos. 5595 and 6226; Mexico, Nos. 5621 and 5630; and Haiti, No. 5593) was there an indication of red color, and in these it was very slight, not nearly enough to confuse it with the 1 per cent test described.

Neither test gave a positive reaction for commercial invert sugar in any of the samples examined, and yet all had been heated enough to liquefy the crystalline honey. Only on boiling the honey for some time or heating to high heat for an undue length of time will these tests give slight reactions in the absence of commercial invert sugar. Boiling is undesirable, as the characteristic honey flavor is lost and the honey becomes dark or black in color.

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[1] U. S. Dept. Agr., Bureau of Chemistry Bul. 110, p. 68.
[2] Zts. angew. Chem., 1908, *21:* 2315.
[3] Deutsche Zuker-Ind., 1906, *31:* 1988.

COMMERCIAL GLUCOSE.

To detect the presence of commercial glucose, the test proposed by Beckman [1] and recommended by Browne was used. It consists in the change in color produced by the treatment with iodin due to the effect of this reagent upon erythro- or amylo- dextrin in the glucose. This test applied to the 72 samples failed to give any indication of the addition of this substance.

SUMMARY.

The results of this study seem to show that beyond a slightly greater moisture content and a somewhat lower percentage of sucrose there are no pronounced differences in chemical composition between the honeys of America and those from the countries specified. Other points, however, must be considered. In this connection, E. F. Phillips, of the Bureau of Entomology, calls attention to the following facts which have a bearing on the admission of these honeys to the United States:

> A disease of the brood of honey bees, American foul brood, is known to be prevalent in Cuba. When honey from an infected colony is fed to bees or when they get such honey accidentally from discarded receptacles the disease may be caused. In the past a number of outbreaks of this disease in the United States have been traced to shipments of Cuban honey. While honey from infected colonies is not injurious to human beings, the danger to bees constitutes a serious objection to the unguarded importation of Cuban honey and affords additional reasons for barring undesirable Cuban honeys from importation.

Furthermore, the preparation of the honey for shipment was very poor. The extraction had been carelessly carried out, and much dirt was present in the samples as received. This comes from the fact that modern methods of beekeeping are not exercised in the localities named to such an extent as in the United States. The honey is mostly wild or that from wild bees, is scooped out of the trees by the natives, allowed to drain through coarse cloth, and shipped either in tins or barrels. In only two cases was the product such as could be sold for direct consumption, these two being comb honey.

Again, with few exceptions the flavor was rank and strong, so that it could hardly be considered palatable. There is some honey of good flavor produced in these places, but it is not exported in any quantity.

Considering the physical condition of the samples as received in nearly all cases, it can be said that they were not fit for human consumption. Reextraction, straining, etc., might improve this condition, but it is a question whether even under this treatment the honey is made fit for table use, as the dirt has become so intimately mixed as not to be removed by physical means.

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[1] Zts. anal. Chem., 1895, *35*: 267.

CHEMICAL LITERATURE ON HONEY FROM 1907 TO 1911

COMPILED BY A. H. BRYAN.

In Bureau of Chemistry bulletin No. 13, Part VI,[1] page 871, will be found a bibliography of honey literature for the years 1867 to 1891, inclusive. In Bulletin No. 110,[2] page 89, will be found a continuation of this up to the first part of 1907. The following compilation takes the literature from this point up to the close of 1911.

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